Analyzing the Relationship Between Trade and Economic Growth

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Abstract

This paper examines how a country's amount of total trade spurs economic growth within countries. The paper will analyze how the total trade activity, measured as the combined level of exports and imports, impacts economic growth, measured as changes in GDP per capita. The model is expanded to include a country's amount of foreign direct investment, gross savings, unemployment level, amount of manufacturing in the economy, and the country's overall status as a developed or developing economy as other potential factors and influencers of economic growth. The final model indicates that the most important influencers of economic growth are foreign investment, savings, unemployment, and the country's development level.

I. Introduction

The export-led growth hypothesis (ELGH) within economic theory, as defined by Emilio Medina Smith (2001), claims that any increase in exports drives the growth of a country and spurs economic development. The ELGH guided the underlying rationale of this paper, that economic growth is dependent on the amount of trade within a country, and aided the choice in variables. While the hypothesis focuses specifically on exports, total trade activity may be a better indication of participation in the global economy as it more fully reflects a nation's international cooperation. The relationship between economic growth and a country's total trade is important for policy makers to understand how to stimulate growth. Domestic trade policies often oscillates between protectionism, the defense of national industries, and trade liberalization, the opening of markets and encouragement of free trade throughout the world. Investigating the impact of total trade on economic growth is crucial for developing trade policies that will grow an economy continuously and efficiently. Considering how the amount of trade, foreign direct investment, and savings impact economic growth provides a well-rounded picture for policy makers to consider when establishing international trade policy. As globalization permeates into the lives of every consumer and into every country, identifying what spurs domestic economic growth is vital for increasing a country's production and influence on the global stage.

The hypothesis behind the simple regression in this paper, which analyzes the impact that trade volume has on economic growth, is that as a country's total trade increases, GDP per capita will increase, indicating economic growth. This hypothesized positive relationship is based on the ELGH and the underlying notion that trade promotes production and therefore overall economic growth. The expanded multiple linear regression predicts that in addition to total trade, increases in investment, savings, and manufacturing will also increase GDP per capita. The model further hypothesizes that increased unemployment levels will negatively relate to GDP per capita and that economies considered to already be "developed economies" will be positively impacted more by trade, with higher GDP per capita.

II. Literature Review

The relationship between trade and economic growth has often been supported by the premise that increased trade liberalization in the modern, globalized world will encourage economic growth. This paper attempts to uncover the most basic relationship between a country's quantity of trade activity, a subsector of globalization and indicator of trade liberalization, along with productivity factors as they impact economic growth. Previous literature has defined trade liberalization in a wide range of ways. Often, studies attempt to utilize pre-established indexes as a measure of trade liberalization in a nation's economy. The differences in definition have led to varied results and little consensus.

A survey of several models of the causal relationship between international trade and economic growth done by Tarlok Singh (2010) found inconsistent trends of data analysis and collection surrounding international trade impacts. In both micro- and macroeconomic settings, it is nearly impossible to untangle the web of data in such a way that provides for conclusive and repeated results. Those that focus on microeconomic growth, where the productivity of a country is the direct correlation of variables that range from research and development to infrastructure, have equally varied data to that of the macroeconomic studies. The wide range of variables considered in the survey led Singh (2010) to conclude that the inconsistencies of the data across the literature make it nearly impossible to find common causal interpretations between various papers. For this reason, the model below is more narrow in scope. A targeted examination of trade and trade's impact on economic growth should reach a conclusion that takes into account the investment that enters a country. As previous literature focused on the impact of barriers to trade as a factor which affects economic growth, Singh's (2010) findings that Member States of the World Trade Organization (WTO) have not seen any more or less benefits from trade than external states cast doubt on the importance of including politically motivated groups which is why economic investment in the domestic economy has been determined to be more fundamental in a country's economic growth for the purposes of this study.

There is little argument that trade liberalization has a number of theoretical impacts on any given economy. In theory, there is improvement of welfare, increased inflow of foreign direct investment (FDI), a reduction in trade costs, increased international political cooperation, and the incentivization of global stability. The reality found in the measurement of these outcomes is scattered at best. Sèna Kimm Gnangnon (2018) assessed the impact of multilateral trade liberalization on countries' economic growth rates. Gnangnon (2018) utilized an index to define trade liberalization. The correlation pattern was apparent between the multilateral trade liberalization index, measured at the Heritage Foundation's freedom of international trade index which examines domestic trade policy, and income growth rates. Notably, the promotion of FDI inflows has a theoretical long term and short term impact on the economy and it is this impact that produced interest in this model. The promotion and explanation of the domestic industries and labor force played into the decision to include both savings and FDI into the new model created below. Gnangnon (2018) found varied impact of trade liberalization based on country income and concluded broadly that the countries already in a better position to accept trade liberalization policies would further benefit from such measures.

In a study done by Shiva S. Makki and Agapi Somwaru (2004), the effects that FDI and trade have on economic growth in developing countries are examined as an indicator of the success of globalization. Trade, along with FDI, is thus a predicted channel of globalization and its integration with modern technology creates an incredibly important formula for economic growth worldwide. In this literature piece, trade is defined as the sum of imports and exports as a percentage of GDP, which helped formulate how trade would be defined in this paper. Makki and Somwaru (2018) strived to produce results to show that trade and FDI work in tandem to promote economic growth. This hypothesis implies that in order for trade to develop and for FDI to drive economic growth, and therefore to actually have some benefit for a developing economy, there must be strong institutions and macroeconomic policies in place. The model goes to show that trade and FDI did positively impact economic growth but neither variable was statistically significant, implying that there may be other variables playing a larger role in determining the magnitude of economic growth within a developing economy. The findings within this literature helped to shape the thought process of this new study and help predict potential outcomes for economic growth in relation to foreign investment and the level of trade within a country.

The model created by this new study brings together elements from many previous models that attempted to find a causal relationship between trade and economic growth. Adding to the complex and ever changing bank of literature on the relationship between trade and economic growth, this paper controls for trade by including domestic investment and savings in an attempt to isolate the effects of trade on economic growth. It similarly accounts for other domestic factors. This paper will include controls for unemployment level, the percentage of trade involved in manufacturing, and whether or not the country is considered to be a developed economy as a means of truly identifying what is the most important factor for economic growth. In the wide realm of trade related economic analysis, the refreshed focus attempts to bring together new ideas and previous findings as the economists chip away to determine the most impactful variables which affect economic growth.

III. Data

While there are seemingly infinite factors that may affect economic growth, the ELGH indicates that trade, specifically exports, drive economic growth. A brief review of the literature indicates that this is a diluted analysis, failing to account for wider global economic participation. Attempting to expand the analysis of globalization’s impact on an individual economies, we have chosen to focus on the total amount of trade and its relationship to economic growth. To measure economic growth, the dependent variable used is GDP per capita, regressed as the log of GDP per capita in the models. We chose to take the log of GDP per capita because it was a more normal distribution than just GDP per capita and would fit better with our data. This is shown in Figure 1, the scatter plot with GDP per capita and Trade, and comparing it to Figure 2, the scatterplot of log(GDP) per capita and Trade.

Figure 1

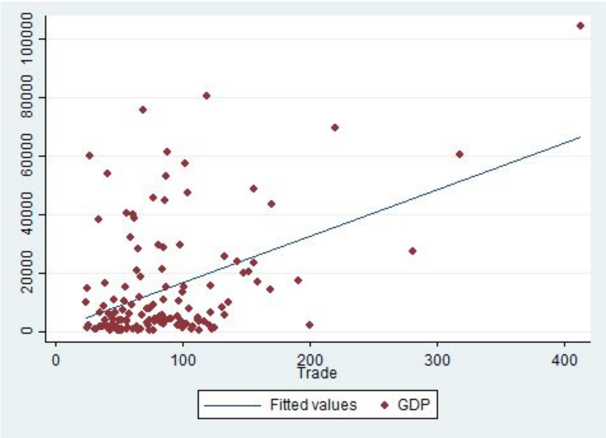
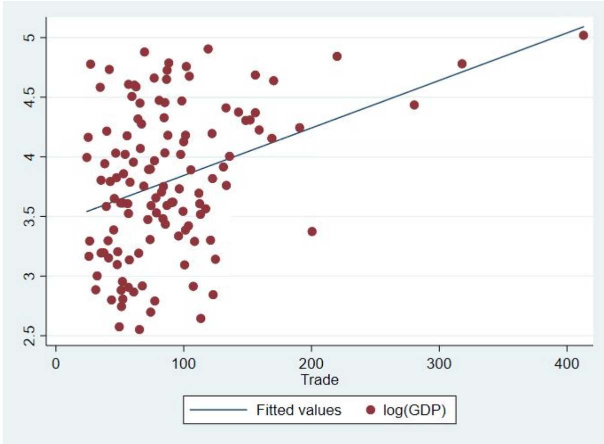


Figure 2



The independent variable in our initial simple regression is trade. Trade is measured as the sum of the imports and exports of goods and services as a percentage of a country's GDP. This measurement was chosen over a country's level of trade, that is exports minus imports, because it reveals the total amount of trade a country is involved in, rather than just their trade balance. Based on the literature, we created this simple model to test that a positive relationship existed between trade activity and economic growth.

Additional variables were included in the multiple linear regression to better determine what impacts economic growth and to decrease any omitted variable bias. The first variables added explored the levels of investment and savings within a country. The investment variable is reported as foreign direct investment, measured as the sum of the net inflows of equity capital, reinvestment of earnings, and other long term capital as a percentage of GDP. It was determined that net inflows are better than net outflows when determining economic growth as incoming FDI is a direct investment into a country's economy. Savings is calculated as the difference between disposable income and consumption plus net transfers, also measured as a percentage of GDP. Later multiple linear regression analyses accounted for unemployment and manufacturing as well. Unemployment is calculated as a percentage of the total labor force that is without work but available and seeking employment. The manufacturing variable is measured as value added to trade within the manufacturing sector, as a percentage of GDP. This is calculated by adding up all the net outputs of those industries and subtracting the immediate inputs. The last independent variable is a dummy variable that assigned 1 to developed countries, as reported by the United Nations, and 0 to countries with developing economies and economies in transition. This variable was added to control for more intangible differences in economies such as differences in infrastructure and political circumstances which affect economic growth.

All of the data for this research was gathered from the World Bank database and the United Nations. The interpretation and source of all of the variables used can be seen in Figure 3. All data used was reported for 2017 with 125 country observations used in this analysis; they are listed in the Appendix. Figure 4 provides descriptive statistics for each of the variables used in the regression model.

Figure 3

Variable	Interpretation	Source
logGDP	Percent of GDP per capita as a measure of economic growth	World Bank
Trade	Sum of exports and imports of goods and services as a percentage of a nation's GDP	World Bank
Investment	FDI measured by the sum of the net inflows of equity capital, reinvestment of earnings, and other long term capital as a percentage of GDP	World Bank
Savings	Difference between disposable income and consumption, including net transfers	World Bank
Unemployment	Unemployment rate measured as a percentage of the total labor force	World Bank
Manufacturing	Net output of the manufacturing sector after adding up all outputs minus intermediate inputs as a percentage of GDP	World Bank
Developed	Takes the value of 1 if a nation's economy is considered developed by the UN and 0 if considered developing or an economy in transition	United Nations

As seen below in Figure 4, for the variables of trade, investment, savings, unemployment, and manufacturing, there are quite large standard deviations, indicating that the mean may not be the best value to use to determine the average. This may be caused by large outliers who have an abnormal amount of trade, investment, or savings in their nation such as the United States, which alone accounts for over 30% of the world's trade volume.

Figure 4

Variable	Mean	Standard Deviation	Minimum	Maximum
logGDP	3.80	0.622	2.55	5.02
Trade	88.49	56.01	24.14	412.87
Investment	4.17	6.80	-10.91	49.76
Savings	22.22	11.57	-48.78	55.64
Unemployment	6.61	4.93	0.14	27.33
Manufacturing	13.20	6.48	1.00	37.28
Developed	0.26	0.44	0.00	1.00

In Figure 2 (above), which depicts the scatter plot for log(GDP) and trade, there are some instances where the amount of trade as a percent of GDP exceeds 100%, such as Luxembourg and Singapore. This can be accredited to nations who participate in large volumes of trade relative to their internal production levels. Countries who serve as entrepot hubs, where goods are processed without any duties or additional packaging, or countries who export in one highly profitable sector may have higher than average trade totals due to the nature of their trade relationships. The nations with the smallest percentages of GDP are developing countries like Brazil, Argentina, and Pakistan. Since these are countries that are developing, they have small amounts of trade as they don't interact as much with other, more developed nations. The other obvious outlier, where trade is 200 and log(GDP) is around 3.3, is Vietnam. This is an interesting outlier as Vietnam is classified as a developing nation by the United Nations but it participates in a large amount of trade compared to other developing nations.

Before running a regression analysis on the data, we must check to determine if it fits the Gauss-Markov Assumptions, used for the multiple linear regressions, and the analogous assumptions for the simple linear regression. Assumption SLR.1 states that the model is linear in parameters. This can be shown by the simple linear regression equation and determines that the x and y values have a linear relationship, expressed in the below equation.

$$y = \beta_0 + \beta_1 x + u$$

Our model meets this condition because there is a linear relationship between GDP per capita and total trade, our dependent and independent variables, respectively.

Assumption SLR.2 states that the data is a random sample drawn from the population. The model meets this condition as the World Bank and the United Nations are trusted sources for data and data analysis. Additionally, the large sample size of 125 countries ensures that the model is accounting for countries with a wide range of incomes, resources, and specializations.

Assumption SLR.3 states that there is standard deviation in the dependent variable, meaning the dependent variable values vary. The data fits this assumption since economic growth, measured as GDP per capita, is different for each country. Assumption SLR.3 is written as follows:

$$\sum(x_i - x)^2 > 0.$$

Assumption SLR.4 is the zero conditional mean assumption. The zero conditional mean is written below and says that the value of the dependent variable cannot contain any information about the value of the unobserved factor, *u*.

$$E(u_i \mid x_i) = 0 .$$

As expected, the model does not meet this assumption. The unobserved factor does contain information about the dependent variable since the simple linear regression could not possibly account for the array of factors which influence GDP per capita. This is expected as it is extremely rare for all of the information to be captured in one independent variable and one relationship.

Since the model does not meet the first four assumptions, it cannot be said that these are unbiased estimators. However, running the simple linear regression will still indicate the relationship between GDP per capita and the total trade but it will simply overestimate or underestimate the relationship.

Lastly, SLR.5 assumes homoskedasticity. This states that the dependent variable cannot contain any information about the variability of the unobserved factors, written as:

$$Var(u_i \mid x_i) = \sigma^2.$$

Homoskedasticity can be assumed for this model because it is likely that the values of the variance are constant for the unobserved factors.

The multiple linear regression must also meet the Gauss-Markov assumptions. Assumptions MLR.1 and MLR.2 are the same as SLR.1 and SLR.2, respectively, so the reasonings above can be applied here as well. MLR.3 states that there is no perfect collinearity between any of the independent variables. Figure 5 shows that there is no perfect collinearity between any of the variables nor are there any highly correlated variables. All of these results are taken from STATA and the output can be seen in the Appendix.

Figure 5

	Trade	**Investment**	**Savings**	**Unemployment**	**Manufacturing**	**Developed**
Trade	1.00					
Investment	0.30	1.00				
Savings	0.12	-0.06	1.00			
Unemployment	-0.03	0.03	-0.15	1.00		
Manufacturing	0.09	-0.10	0.34	-0.11	1.00	
Developed	0.36	0.09	0.11	0.07	0.11	1.00

MLR.4 is the same as SLR.4, the zero conditional mean assumption. However, it can now be expressed as the following equation for a multiple linear regression:

$$E(u_i \mid x_{i1}, x_{i2},\ldots,x_{ik}) = 0.$$

The addition of independent variables means less information is contained within the unobserved factor, *u*. The model is still likely to have bias but including more independent variables narrows the margin of error and makes the estimates more accurate.

Lastly, MLR.5, like SLR.5, assumes homoskedasticity. Once again, the assumption is made for this model because it is likely that the values of variance are constant for the unobserved factors.

IV. Results

The simple linear regression of the log of GDP per capita and trade shows a statistically significant, positive relationship between economic growth and total trade. Below is the econometric equation for the simple linear regression model:

$$logGDP = 3.445 + 0.004(Trade)$$

The simple linear regression shows that as the amount of trade as a percent of GDP increases by 1%, a country's GDP per capita will increase by 0.4%. While the coefficient is small, this may be explained by the small range of *logGDP*. Further, the relationship between amount of trade and GDP per capita is positive, aligning with the hypothesis developed based on a review of the literature. The regression directly explains approximately 13% of the data, indicated by an R-squared value of 0.13.

The first multiple linear regression was developed to account for domestic savings and investment into a country's economy, an influential factor of economic output, widely accepted in economic theory. The STATA results can be seen in the Appendix. The econometric equation is:

$$logGDP = 3.122 + 0.004(Trade) - 0.003(Investment) + 0.016(Savings)$$

The regression reflected the anticipated positive relationship between trade and GDP per capita and savings and GDP per capita. Ceteris paribus, a 1% increase in trade results in a 0.4% increase in GDP per capita and a 1% increase in savings results in a 1.6% increase in GDP per capita. Contrary to what the literature suggested, a 1% increase in investment (FDI) resulted in a 0.3% decrease in GDP per capita. The negative relationship between investment and economic growth is economically counterintuitive and contrary to the literature. The relationship between these independent variables and the economic growth indicator variable explains 22% of the data based on the R-squared value of 0.22. While including savings and investment incorporated more data into the model, the low R-squared and unexpected negative relationship required the multiple linear regression model to be expanded further.

The second multiple linear regression attempted to account for more sectors of the domestic economy to better develop and explain the relationship between trade and economic growth. The variables unemployment, manufacturing, and developed were added to create the following econometric equation:

$$logGDP = 2.905 + 0.001(Trade) - 0.002(Investment) + \\ 0.013(Savings) + 0.021(Unemployment) + 0.010(Manufacturing) + 0.813(Developed)$$

This second multiple linear regression, like the first, demonstrated positive relationships between all variables except investment, which once again showed a negative correlation with GDP per capita. All of the variables had small coefficients, demonstrating relatively flat linear relationships. The model shows that as trade increases by 1%, GDP per capita increases by only 0.1%. Similarly small, as investment increases by 1%, GDP per capita decreases by 0.2%. The model shows that as unemployment and manufacturing each increase by 1%, GDP per capita will increase by 2.1% and 1%, respectively. The positive relationship between GDP per capita and unemployment did not align with the original hypothesis and appears to be economically counterintuitive. The model indicates that developed countries have an 81.3% overall increased GDP per capita. Of these variables, savings, unemployment, and developed were all significant at the 1% level while trade was significant at the 10% level. The investment and manufacturing variables were not significant in this regression. This multiple linear regression did better in explaining the model than the first multiple linear regression. In this instance, 56% of the data was explained as seen by the R-squared value of 0.56.

The second multiple linear regression variables did not explain economic growth with enough significance to be a final model. Due to the high multicollinearity between several variables including manufacturing and savings and trade and developed, joint significance tests were conducted to establish the importance of these variables. Details of the joint significance tests can be found below in the Extensions section.

The third multiple linear regression, seen below, removes the trade and manufacturing variables:

$$logGDP = 3.084 + 0.0004(Investment) + 0.016(Savings) + 0.019(Unemployment) + 0.883(Developed)$$

In this model, only investment, savings, unemployment level, and developed are included as indicators of economic growth. All of the coefficients associated with these variables correlate with the original prediction, except for unemployment, that these effects would have a positive influence on economic growth within a country. The model shows that as investment increases by 1%, GDP per capita increases by 0.04%, a small but positive correlation. As savings increases by 1%, GDP per capita increases by 1.6%, similar to the first multiple linear regression model. A 1% increase in unemployment results in a 1.9% increase in GDP per capita; this positive relationship again seems to be counterintuitive. According to the model, developed countries have a GDP per capita that is greater by 88.3%. This final model explains 54% of the data, shown by the R-squared of .54.

The removal of the initial variable of interest serves to indicate the relatively low value of trade as it relates to the growth of an economy. If anything, the strong correlation between developed and trade indicates that trade is the result of an already mature economy that has previously experienced significant growth over an explanatory factor for economic growth today.

A summary table is provided below in Figure 6 of all of the regressions, simple and multiple. The table lists the coefficients of each variable, the associated standard error, the R-squared and adjusted R-squared, and indicates whether or not the variable holds any significance.

Figure 6

Variable	**SLR**	**MLR I**	**MLR II**	**MLR III**
Trade	0.00399*** (0.000934)	0.00368*** (0.000942)	0.00136* (0.000764)	
Investment		-0.00276 (0.00772)	-0.00185 (0.00590)	0.000389 (0.00571)
Savings		0.0163*** (0.00436)	0.0139*** (0.00353)	0.0162*** (0.00340)
Unemployment			0.0207*** (0.00785)	0.0191** (0.00794)
Manufacturing			0.00964 (0.00628)	
Developed			0.813*** (0.0937)	0.883*** (0.0892)
_cons	3.445*** (0.0978)	3.122*** (0.129)	2.905*** (0.131)	3.084*** (0.109)
R-squared	0.129	0.222	0.562	0.540
Adj. R-squared	0.122	0.202	0.539	0.525

Values in parentheses represent standard error Significant at: *10%, **5%, ***1%

As seen in Figure 6, in the final multiple regression model, the two variables savings and developed are significant at the 1% level and one variable, unemployment, is significant at the 5% level. The statistical significance of these variables can be proven using a t-test, p-values, and confidence intervals. The corresponding t-values, p-values, and 95% confidence intervals are listed below for the third multiple linear regression model. All of the data in Figure 7 was provided by the STATA output for MLR III, which is located in the Appendix.

Figure 7

Variable	Coefficient (Standard Error)	t-value	p-value	95% Confidence Interval
Investment	0.0004 (0.0057)	0.07	0.946	(-0.011, 0.012)
Savings	0.0162 (0.0034)	4.77	0.000	(0.0095, 0.023)
Unemployment	0.019 (0.0079)	2.40	0.018	(0.0034, 0.0348)
Developed	0.883 (0.089)	9.90	0.000	(0.706, 1.060)

The following hypothesis test will be used to test the significance of each variable in MLR III, where β_k represents all of the independent variables, β_1 through β_4.

$$H_0: \beta_k = 0$$

$$H_1: \beta_k \neq 0$$

Using the t-values of each independent variable in MLR III, seen above in Figure 7, the significance of each variable can be determined by performing a t-test. The t-test compares the t-value and the critical value of the t-distribution. Two-tailed t-tests are used as the objective is to determine whether or not the coefficient of each variable is significantly different from zero, without regard for whether it is a positive or negative value. With 125 observations, there are 120 degrees of freedom for all of the t-tests. The critical value for a two-tailed t-test with 120 degrees of freedom at a significance level of 1% is 2.617. If the absolute value of the t-value is greater than the critical value at any specific significance level, then the null hypothesis can be rejected, indicating that the variable is statistically significant and different than zero. At the 1% level, the variables savings and developed are significant because their t-values are greater than the critical value. For a 5% significance level, the critical value for a two-tailed t-test with 120 degrees of freedom, is 1.980. As seen in Figure 7, the t-value for the variable unemployment is greater than this critical value, but less than the critical value at the 1% significance level, which implies that unemployment is significant at 5% but not 1%. The last variable in MLR III, investment, is not significant at any level because its t-value is so low that it is not greater than any critical value at any significance level (10%, 5%, or 1%).

The same hypothesis can be tested using p-values as well. The p-values for each independent variable are also included in Figure 7. The p-value is the smallest level at which the null hypothesis is rejected. The p-values for savings and developed are 0.000. Since these p-values are less than 0.01, which corresponds to a 1% significance level, the p-values support the statistical significance that was proven using the t-test, namely that the variables savings and developed are significant at the 1% significance level. The p-value for unemployment is 0.018, which is between 0.01 and 0.05, and implies that the minimum rejection level is 1.8%. The variable unemployment is therefore not significant at 1% but is significant at 5%. The variable investment has a large p-value of 0.946, which supports the earlier t-test conclusion that investment is not significant at any level of significance.

A third test of our hypothesis can be proven using 95% confidence intervals. The 95% confidence intervals for the independent variables in MLR III can also be seen in Figure 7. A 95% confidence interval implies that there is a 5% chance the coefficient of the variable lies outside of the confidence interval. If zero is within the confidence interval, then it is inferred that the null hypothesis fails to be rejected and the coefficient is not necessarily significantly different than zero. Of the variables in MLR III, zero does not lie in the interval of the variables savings, developed, and unemployment, which shows that all of the associated coefficients are significantly different than zero at a 5% significance level. The null hypothesis that the coefficient is equal to zero can therefore be rejected for these three variables.

V. Extensions

As the models in this paper expanded from the simple linear regression model, we sought to identify more explanatory variables that would help better explain the dependent variable. In order to do that, we chose to add a dummy variable to control for whether or not the country was considered developed or developing. The addition of this dummy variable increased our R-squared significantly since the model began to control for the difference in country categories, whether it be developed or developing. Depending on which category the country is in will determine how large of an effect savings, investment, and trade will have on GDP per capita and therefore on economic growth.

Removing the variables trade and manufacturing as independent variables in MLR III was decided after performing F-tests on the joint significance of the collinearity between trade and developed and between manufacturing and savings. The decision to test the collinearity between these two sets of variables was due to the fact that these sets of variables had two of the highest collinearity coefficients, which can be seen in Figure 5.

To calculate the F-value for the joint significance test between trade and developed, we need to create an unrestricted model that includes all of the variables within MLR II and a restricted model that does not include either trade or savings. To test whether or not trade and developed are jointly significant, we will use the following hypothesis test:

$$H_0: \beta_1 = \beta_6 = 0$$

$$H_1: H_0 \text{ is not true}$$

To calculate the F-value, we will use the calculation with the R-squared values of the restricted and unrestricted models. The R-squared of the restricted model is 0.1883 and the R-squared of the unrestricted model is 0.5616. The below calculation shows the F-value for trade and developed:

$$F = [(R^2_{ur} - R^2_r)/q] / [(1-R^2_{ur})/(n-k-1)]$$

$$F = [(0.5616\text{-}0.1883)/2] / [(1\text{-}0.5616)/118)] = (0.1867)/(0.0037) = 50.446$$

This calculated F-value is much larger than the associated critical value, which is 3.07 for a test that has a numerator degrees of freedom equal to 2 and a denominator degrees of freedom equal to 118. Since the F-value is larger than the critical value, the null hypothesis can be rejected that each of the coefficients are not jointly significant and not significantly different than zero. This leads us to the conclusion that the two variables are jointly significant at a 5% significance level. This implies that a country's level of trade and whether or not it is a developed country both have a similar impact on the log of GDP per capita in this model. Due to this joint significance, one of these variables can be removed from the model and we chose to remove trade because the developed variable was more significant in MLR II and accounted for more factors of GDP per capita than trade. When trade was dropped, the variable developed grew more positive and remained significant at the 1% level.

To check the joint significance of manufacturing and savings, we performed a similar F-test to test the joint significance between the two explanatory variables. We again created a restricted model, excluding savings and manufacturing, and an unrestricted model that included all variables, namely our MLR II. As done previously, we used the R-squared F-test to test the following hypothesis:

$$H_0: \beta_3 = \beta_5 = 0$$

$$H_1: H_0 \text{ is not true}$$

The R-squared values of our restricted and unrestricted models were 0.4732 and 0.5615, respectively. To calculate the F-value, the following calculation was performed:

$$F = [(R^2_{ur} - R^2_r)/q] / [(1-R^2_{ur})/(n-k-1)]$$

$$F = [(0.5616\text{-}0.4732)/2] / [(1\text{-}0.5616)/118)] = (0.044)/(0.0037) = 11.946$$

This F-value, similar to above, was also significantly larger than the critical value at 5%, with numerator degrees of freedom equal to 2 and denominator degrees of freedom equal to 118. The critical value, which again was 3.07, is much less than the F-value of 11.946, implying that the null hypothesis can be rejected and that the two variables are jointly significant. This joint significance means that one of the variables can be dropped from the model. The variable dropped was manufacturing because our thought process led us to believe that savings would be better at explaining changes in GDP per capita. Savings was also significant at the 1% level in MLR II whereas manufacturing was insignificant at all levels. Removing manufacturing increased the coefficient of savings and kept savings significant at the 1% level.

VI. Conclusions

The findings overall led to a rejection of our original hypothesis, that trade would have a strong positive correlation with the log of GDP per capita, which was representative of economic growth. In accounting for outside factors that impact economic growth, we found that while trade does impact growth, ultimately it may serve more as an indicator of already globalized nations. We reached this conclusion when the joint significance of trade and developed was tested based on the high multicollinearity. The constant of the repeated multiple linear regression models was the high significance of savings on economic growth. If anything, the final model proved that the more funds are put into developing a domestic economy, the greater the economic growth. From the final regression, we determined that savings and the developed variable were statistically significant at the 1% level while unemployment was statistically significant at the 5% level. This is supported by general macroeconomic theory. Savings, measured as disposable income as a percent of GDP, shows how changes in GDP per capita directly respond to the demand in the domestic economy. While investment, measured as FDI inflows, was not a significant number, we found it to be a crucial indicator of the openness of the domestic economy to global markets and the international community.

Economic growth can be impacted by a wide variety of factors and this model only encapsulated the ones we deemed important for the scope of this research paper. To truly determine the scope and impact of trade and trade liberalization on economic growth, it is important to narrow the scope of the model. Examining a full economy and economic structure required many variables to be accounted for and reducing the field perhaps by sector or some other form may allow a more significant and nuanced relationship between trade and economic growth to be uncovered.

VII. References

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VIII. Appendix

Stata Outputs

Multicollinearity:

```
. corr Trade Investment Savings Unemployment Manufacturing Developed
(obs=125)
```

	Trade	Invest~t	Savings	Unempl~t	Manufa~g	Develo~d
Trade	1.0000					
Investment	0.2951	1.0000				
Savings	0.1197	-0.0579	1.0000			
Unemployment	-0.0336	0.0283	-0.1543	1.0000		
Manufactur~g	0.0928	-0.0969	0.3352	-0.1097	1.0000	
Developed	0.3628	0.0949	0.1067	0.0686	0.1071	1.0000

Simple Linear Regression:

```
. regress logGDP Trade
```

Source	SS	df	MS
Model	6.17707484	1	6.17707484
Residual	41.8080849	123	.33990313
Total	47.9851598	124	.386977095

Number of obs	=	125
F(1, 123)	=	18.17
Prob > F	=	0.0000
R-squared	=	0.1287
Adj R-squared	=	0.1216
Root MSE	=	.58301

logGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Trade	.0039852	.0009348	4.26	0.000	.0021347	.0058356
_cons	3.445476	.097784	35.24	0.000	3.251919	3.639034

Multiple Linear Regression I:

```
. regress logGDP Trade Investment Savings
```

Source	SS	df	MS
Model	10.6386627	3	3.54622091
Residual	37.346497	121	.308648736
Total	47.9851598	124	.386977095

Number of obs	=	125
F(3, 121)	=	11.49
Prob > F	=	0.0000
R-squared	=	0.2217
Adj R-squared	=	0.2024
Root MSE	=	.55556

logGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Trade	.0036812	.0009421	3.91	0.000	.0018161	.0055464
Investment	-.0027622	.00772	-0.36	0.721	-.018046	.0125216
Savings	.0162865	.0043644	3.73	0.000	.0076459	.024927
_cons	3.121992	.1285206	24.29	0.000	2.867551	3.376432

Multiple Linear Regression II:

```
. regress logGDP Trade Investment Savings Unemployment Manufacturing Developed
```

Source	SS	df	MS
Model	26.9470112	6	4.49116854
Residual	21.0381486	118	.178289394
Total	47.9851598	124	.386977095

Number of obs	=	125
F(6, 118)	=	25.19
Prob > F	=	0.0000
R-squared	=	0.5616
Adj R-squared	=	0.5393
Root MSE	=	.42224

logGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Trade	.0013556	.0007642	1.77	0.079	-.0001577	.0028689
Investment	-.0018488	.0059009	-0.31	0.755	-.0135343	.0098366
Savings	.0139263	.0035328	3.94	0.000	.0069304	.0209221
Unemployment	.0206794	.0078493	2.63	0.010	.0051355	.0362232
Manufacturing	.0096447	.0062756	1.54	0.127	-.0027826	.0220721
Developed	.8133578	.0937454	8.68	0.000	.6277163	.9989993
_cons	2.905168	.130857	22.20	0.000	2.646035	3.1643

Multiple Linear Regression III:

```
. regress logGDP Investment Savings Unemployment Developed
```

Source	SS	df	MS
Model	25.906227	4	6.47655675
Residual	22.0789328	120	.183991107
Total	47.9851598	124	.386977095

Number of obs	=	125
F(4, 120)	=	35.20
Prob > F	=	0.0000
R-squared	=	0.5399
Adj R-squared	=	0.5245
Root MSE	=	.42894

logGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Investment	.0003885	.005707	0.07	0.946	-.0109109	.0116879
Savings	.0162142	.0034012	4.77	0.000	.0094801	.0229482
Unemployment	.019087	.0079447	2.40	0.018	.0033569	.034817
Developed	.8829899	.0891995	9.90	0.000	.706381	1.059599
_cons	3.083961	.1085421	28.41	0.000	2.869055	3.298867

Countries Used in Research

Afghanistan, Angola, Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Belgium, Benin, Burkina Faso, Bangladesh, Bulgaria, Bahrain, Bosnia and Herzegovina, Belarus, Belize, Bolivia, Brazil, Brunei Darussalam, Bhutan, Botswana, Switzerland, Chile, China, Cote d'Ivoire, Cameroon, Colombia, Cabo Verde, Costa Rica, Cyprus, Czech Republic, Germany, Djibouti, Denmark, Dominican Republic, Algeria, Ecuador, Egypt, Arab Rep., Spain, Estonia, Ethiopia, Finland, France, United Kingdom, Georgia, Ghana, Guinea, Guinea-Bissau, Greece, Guatemala, Honduras, Croatia, Hungary, Indonesia, India, Ireland, Israel, Italy, Jamaica, Jordan, Japan, Kazakhstan, Kenya, Kyrgyz Republic, Cambodia, Korea, Rep., Kuwait, Lebanon, Liberia, Sri Lanka, Lithuania, Luxembourg, Latvia, Morocco, Moldova, Mexico, Malta, Myanmar, Montenegro, Mongolia, Mozambique, Mauritius, Malawi, Malaysia, Namibia, Niger, Nigeria, Nicaragua, Netherlands, Norway, Nepal, Oman, Pakistan, Panama, Peru, Philippines, Portugal, Paraguay, Qatar, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Singapore, Sierra Leone, El Salvador, Slovak Republic, Slovenia, Sweden, Togo, Thailand, Tajikistan, Timor-Leste, Tunisia, Turkey, Tanzania, Uganda, Ukraine, Uruguay, United States, Vietnam, South Africa, Zimbabwe